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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 317.

Experiment Station Work, XLV.

Compiled from the Publications of the Agricultural Experiment Stations.

THE FARM HOME.

LINING OF DITCHES AND RESERVOIRS.

CEMENT PIPE FOR IRRIGATION AND
OTHER PURPOSES.

POLLINATION OF FORCED TOMATOES.

INCREASING THE PRODUCTIVENESS
OF CORN.

SHRINKAGE OF CORN IN CRIBS.

GRAIN FOR COWS AT PASTURE.

STARTERS FOR RIPENING CREAM.

WATER PANS FOR POULTRY.

CATCHING HOOK FOR POULTRY.

JANUARY, 1908.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.^a

IMPROVING THE CONVENIENCE AND COMFORT OF THE FARM HOME.^b

The question of sanitary appliances and other conveniences for the farm home has been discussed in a Farmers' Bulletin recently published by this Department.^c Preparation of vegetables for the table, making of jams and preserves, and various problems concerned with the nutritive value of food and its reference to dietetics have also been discussed in Farmers' Bulletins.^d

A number of the agricultural colleges and experiment stations have studied questions which have a direct bearing on the convenience and comfort of the farm home, such work in the agricultural colleges usually being done in the home economics department. Dr. Edna D. Day, who has charge of such a department at the Missouri Agricultural College, has recently discussed the need for convenience in the construction of the farm home, the value of labor-saving devices, and related questions.

PLANNING THE HOME.

In this connection she notes that in planning a home it is essential that the rooms should be located with a view to convenience in carrying on household tasks. "Be very careful in making the plans that you put more money into convenience than you do into size. Many a prosperous farmer, on rebuilding his home, has felt rich enough to make a house so large that his wife has not yet found time enough for its proper care. Not only are there more square feet of floor to be swept, but the steps necessary to do the ordinary routine work of the house have been multiplied many times."

^a A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

^b Compiled from Ann. Rpt. Mo. Bd. Agr., 39 (1906), p. 101; Boston Cooking School Mag., 12 (1907), p. 240; Cornell Reading Course for Farmers' Wives, 3. ser., 1905, No. 14.

^c U. S. Dept. Agr., Farmers' Bul. 270.

^d U. S. Dept. Agr., Farmers' Buls. 34, 74, 85, 93, 112, 121, 128, 142, 182, 203, 234, 249, 256, 293, 295, and 298.

In earlier times the farmhouse kitchen, commonly the largest room in the house and usually a pleasant, homelike room, often served as a dining room and living room as well, and one or more of the bedrooms were on the same floor as the kitchen. This meant a saving of time, since the housewife had fewer rooms to care for and fewer steps to take than is the case in the more modern farmhouse with a separate dining room and living room and with sleeping rooms in the second story. The more modern house undoubtedly has its advantages and is in accord with present-day standards of living, but such an extension of space should be counterbalanced by convenience of arrangement, the use of labor-saving devices, and all possible household conveniences.

As Professor Day points out, the proper location of the kitchen and dining room, the china closet, the kitchen sink, stove, and work table means a saving of very many unnecessary steps and much useless labor. If food must be kept in the cellar in summer time a dumb waiter with two or three shelves running from the kitchen to the cellar is well worth its cost. Of course, an ice box on the ground floor would avoid the necessity for keeping food cool in the cellar. If an ice box is used it should be so located that it can be conveniently filled with ice and yet be near the kitchen. Convenient cellar stairs are much less common than they should be, and their location, lighting, etc., are questions which should always be taken into consideration in house construction.

For use in cold weather "there should be a pantry on the ground floor in which the food is kept, and this pantry should be within walking distance of the dining room and kitchen. If this is not possible, a box can be turned on its side and fastened just outside the kitchen window and the food kept in it."

If your house has been built without care to step saving in the position of dining table, sinks, and cupboards, a small table on rollers, especially if its capacity is increased by a lower shelf, will be found a great convenience. It can be used to advantage in setting and clearing the table. It is also helpful to have near the sink when the dishes are washed. They can be put on it and the table then moved to the china closet and emptied. Many a woman who is now tired of an evening would be fresh if she used [a wheeled table like this and] a high stool at the sink and work table.

A recent writer who discusses the construction and arrangement of a house that may be conveniently cared for by the housewife herself insists that the rooms "in which daily work is done must be centrally located. Bring the living room near the kitchen and your own bedroom as close to both as possible." If a dining room is considered essential it must be conveniently located, but the use of the living room as a dining room in winter and a screened porch for this purpose in summer is spoken of as an alternative.

A cart with compartments and mounted on small wheels is mentioned as a labor saver in the preparation and serving of meals. As

an essential, hot water for bath and kitchen use in summer and winter is insisted upon as well as few rooms to take care-of, all the rooms being large except the kitchen, for within reasonable limits the smaller the kitchen the fewer the steps which will be taken in the kitchen work.

The model kitchen has four windows. One whole side of the room is lined with cupboards, some with glass doors, others of solid wood; beneath are drawers and flour bins. The * * * range stands conveniently near the work table, and there is also a large enameled sink with draining board. Between the large screened-in porch and the kitchen is placed the refrigerator, being filled with ice from the outside. The refrigerator doors open into the kitchen. Many times a day the cold storage has to be gone to, and this is an important matter, to have it right at hand. You will find that there is not any more ice consumed in a summer than if the ice chest was in the cellar. Why should steps be multiplied in going to it? The kitchen in the labor-saving planned house is small. The more articles you can reach with fewest steps, the lighter your work will be. * * * A narrow kitchen is a great labor saver. One does not realize this until she prepares a meal in the large square old-fashioned kitchen; the extra steps count as miles in a day.

USE OF LABOR-SAVING APPLIANCES.

The general use of the sewing machine has saved the farmer's wife and other housekeepers unnumbered hours of labor, and in the same way the general use of the proper kitchen conveniences will prove equally advantageous. It is just as important to supply the farmer's wife with carpet sweeper, washing machine, bread mixer, and other labor-saving devices, and with sharp knives, egg beaters, measuring cups, and other kitchen conveniences as it is to use separators in the dairy or other modern appliances in general farm work.

In a summary of data prepared for farmers' wives in connection with the extension work of the New York Agricultural College and Experiment Station, the need for kitchen conveniences is insisted upon. "A clerk does not like a poor pen, a typewriter a poor machine, nor a carpenter a poor saw. So the expeditious cook objects to poor cooking utensils. They are a bar to progress, a menace to the success of her enterprise, and a serious temptation to her serenity of temper. Stirring cake with a small, frail spoon, beating eggs with a loose-jointed egg beater, as well as many other crippling processes, should not be her lot to endure." As the writer quoted points out, the needed utensils cost money, but so do all labor-saving and useful devices, and it is fitting to ask whether the labor-saving devices in the house have kept pace with those purchased for use in the barn or fields. If the farmer's wife and daughters can economize in time and energy required for household tasks they will have leisure for other duties and pleasures and for rest and recreation.

FOOD.

Rational living on the farm or in any other community presupposes a reasonable variety of well-cooked foods of good quality with the various sorts in suitable proportion. In many homes the house-keeping is needlessly complicated and the result obtained is out of proportion to the labor expended. In other homes, particularly where the variety of easily obtainable foods is limited and the proper preparation of foods is not given due attention, the diet is too monotonous to be satisfactory or is so prepared that it is not well suited to the family needs. The question of lessening household labor by avoiding unnecessarily elaborate dishes and meals is discussed in the Cornell Agricultural College and Experiment Station publication referred to.

In our own country the difference between the present table and that of the pilgrim fathers is so great as to account to some extent for the present lack of leisure of the housewife. To fish, brown bread, pork and beans, vegetables, have been added the present salads, ices, elaborate puddings, cakes, and the many forms of dessert. [In the earlier times] * * * there was a regular baking day, when large quantities of baked beans, pies, and bread were prepared.

The baking day and the preparation of large amounts of food at one time, with the consequent economy of labor, are much less common than was once the case. Changes in customs and standards of living and a more varied food supply have led to the selection of many dishes which are best if freshly prepared and to menus which are very often needlessly elaborate. All this means added work for the housekeeper. The careful selection of food and the planning of meals will do much to lessen household labor, and if this is done with due reference to nutritive value of foods and wholesome combinations the results will oftentimes be more satisfactory than is at present the case.

All are coming to know that simpler living is necessary, not only for the comfort of the housekeeper but for those who sit at her table. Elaborate menus are entirely impossible when one woman does all the work. * * * The elaborate meals and the unnecessary dishes are not for the good of anyone. They interfere with the beautiful grace of hospitality; they prevent the happiness of the cook and the preservation of her strength. Simple, wholesome meals, with intelligent cooking and serving, are a blessing to any household.

In homes where the diet is too monotonous and the preparation of food is not in accordance with right standards of living, the knowledge of proper methods and ways of utilizing available food supplies will result in a much more satisfactory diet with the same amount of labor, or indeed oftentimes with less expenditure of time and energy.

Commenting on the lack of variety in food noticeable on many busy farms and ways in which it may be obviated, Professor Day makes the following statement: "Most farmers have to depend on chickens for the greater part of their fresh meat, and unless one is in the poultry

business the care of chickens is another burden added to the household." The increased time which labor-saving devices in the home and convenient construction of the farmhouse make possible would give the farmer's wife time for her poultry, and then poultry keeping need not be a burden. There should certainly be no lack of fresh vegetables on the farm, but frequently the farmer can not give the necessary time to the kitchen garden and the farmer's wife is unable to find time for gardening, though most women doubtless consider gardening a recreation rather than a task. "If only the men can do the first hard work in the garden and see that the indoor burdens are lightened, most women will welcome the opportunity for work out of doors among the green things, and will be the better for it physically."

The above statements make it plain that if the diet is out of harmony with rational standards, either because it is too elaborate or because it is too monotonous or unsatisfactory in other ways, it is possible by the application of knowledge now available to improve conditions and at the same time lessen the housewife's burdens.

In few departments of home life has there been so much improvement in the last one hundred years in the economy of labor and fuel and in scientific methods as in cookery. It remains, therefore, for the housewife to take advantage of the gain in time and labor to study the kind and quantity really necessary, and the best and simplest way of preparing food, in order that she may have time at her disposal for the other duties in and out of the home and to add to her own leisure and means of self-improvement.

HYGIENIC CONDITIONS AND COMFORT.

Professor Day also calls attention to the need of home conveniences with reference to comfort and hygienic conditions. Flies and other household insects not only make work for the housekeeper, but are active agencies in the spread of disease, and there is every reason why they should be kept out of the house by screens at windows and doors. Much may also be done to prevent the breeding of such insect pests. Proper drains and other sanitary conveniences not only lighten the housekeeper's duties, but are also of the utmost importance in the hygiene of the home.

The isolated home needs not only to use special care to make its numerous duties easily done, and to be most careful of all health conditions. * * * but it has also special problems in educative recreation.

"Home is peculiarly the place of rest, though the birthplace of all industries." * * * The home has not kept pace with the industrial world in improving the methods of adjusting household affairs. Housework should be carried on with no more loss of time or energy than is involved in the conduct of any well-managed business. To be independent we must sacrifice many of the customs to which we cling. The old order is passing away and the sacredness of home will not suffer, but, instead, we will have a greater development and more opportunities for freedom and happiness.

Recreation and amusement are essential features of a normal life and are as much the right of the farmer's family as of those who live in larger communities, to whom music, art, and many other forms of rec-

reation involving high ideals are more conveniently accessible. However, by means of books, farmers' institute work, lectures, traveling schools, clubs for home study, etc., much that is really best is within the reach of all. The lightening of home burdens by means of a well-equipped and hygienic house, by the use of household conveniences, and by the proper understanding and systematizing of home work, means that the home maker and her family may have opportunity for something beside the daily tasks which too often leave neither time nor inclination for recreation.

LINING OF DITCHES AND RESERVOIRS TO PREVENT SEEPAGE LOSSES.^a

In a recent bulletin of the California Station E. Mead and B. A. Etcheverry call attention anew to the enormous waste of irrigation water due to seepage from ditches and reservoirs. They show from general observation and from a large number of careful measurements that "the water which sinks into the soil from ditches and reservoirs is one of the chief sources of waste in irrigation. In gravelly soils, or where ditches cross gypsum strata, the losses sometimes amount to more than half the total flow." Measurements made on a large number of ditches in the course of the cooperative irrigation investigations of the Office of Experiment Stations and the California Station "show an average loss on main canals of about 1 per cent for each mile that water is carried; on laterals the loss amounted to between 11 and 12 per cent per mile; while on some California canals the loss in a single mile was 64 per cent. * * * Measurements made in 1906 on a storage reservoir having a surface of 10,000 square feet showed a seepage loss of 1,000 cubic feet per day. The reservoir is filled by a windmill, and this loss was 10 per cent of the average quantity pumped each day—a loss too heavy to be borne. The problem of this reservoir owner is the problem of hundreds of irrigators. * * *

"The water which escapes is often worse than wasted. It collects in the lower lands, fills the soil, drowns the roots of trees and plants, brings alkali to the surface, and is a prolific breeding place for mosquitoes."

In the course of the same investigations attempts were made to find practical means of lining storage works and canals and ditches to prevent or at least to reduce this waste and consequent loss. "From the results obtained the conclusion was reached that on large and costly aqueducts or important storage works, linings of cement, concrete, or asphaltum may be employed without the expense being prohibitive." It is pointed out, however, that a very large proportion of the irrigation of the country is done by means

^a Compiled from California Sta. Bul. 188.

of the smaller, cheaper reservoirs and other works, the owners of which "can not afford the expense needed to line the reservoir with concrete or asphalt because the value of the water stored will not justify this expense."

In view of the fact that the greater proportion of the losses occur on lateral ditches and small storage basins, it is necessary to find some simpler and cheaper, but efficient, lining which can be applied by farmers and unskilled laborers. It is clear that the general use of such a method would result in a great improvement of irrigation practice and a marked increase in the duty of water.

Puddling was tried, but as a rule there was not sufficient clay in the soil to make this efficient. A natural silting up, with consequent improvement of water-holding capacity, of reservoirs and ditches carrying muddy water frequently occurs, but a large proportion of the irrigation water used, notably that obtained by pumping, is clear, and therefore no silting results.

Of the large number of available raw materials promising well as ditch and reservoir lining, cement, clay, and crude petroleum were tested as ditch linings in the California experiments. The principal results of the test are given in brief in the following table:

Results of tests of various ditch linings.

Description of lining.	Efficiency ratios.	Saving.	Experimental cost of lining per square foot.	Actual cost of lining per square foot.
		<i>Per cent.</i>	<i>Cents.</i>	<i>Cents.</i>
Cement concrete, 3 inches thick.....	7.17	86.6	8.30	7.50
Cement-lime concrete, 3 inches thick.....	2.00	65.5	8.30	7.50
Cement mortar.....	2.73	63.3	3.88	3.25-3.50
Heavy oil, 3½ gallons per square yard.....	2.02	50.4	1.20	1.20
Clay puddle, ¾ inches thick.....	1.78	47.8	3.90	1.20
Heavy oil, 3 gallons per square yard.....	1.50	38.0	1.00	1.00
Heavy oil, 2½ gallons per square yard.....	1.37	27.3	.77	.77
Thin oil, 2½ gallons per square yard.....	1.08	7.3	1.00	.80
Earth (no lining).....	1.00	0.0		

The table shows wide variations in the efficiency and cost of the different lining materials.

While there is no doubt that cement concrete is the most efficient as regards seepage, it is also the most expensive, being more than six times the cost of the heavy oil lining (3½ gallons per square yard), which saves 50.4 per cent of the water which would seep were the ditch not lined. This saving with the concrete ditch is 86.6 per cent, or one and three-fourths times as large. Where water is very valuable there is no doubt but that the concrete ditch is more permanent and economical. But where the water is not so scarce and a little waste will do no damage, the expense of lining the ditch with oil may be justified, while a more expensive lining would be impracticable. * * *

The puddle lining in the experiment showed a saving in seepage nearly equal to the heavy oil lining when 3½ gallons of oil per square yard was used, and a greater saving than the other oil linings. This puddle lining, whose thickness was ¾ inches,

would no doubt, if made thicker, be more efficient than any of the oil linings as regards seepage; but clay puddle when wet becomes very soft and will not resist the erosive force of the flowing water unless the velocity is very small. It will not prevent the growth of weeds. For these reasons it is probably not as efficient for canal linings as oil. But where clay is plentiful it would be preferable for reservoir lining. The slopes should, however, be protected against the erosive action of the waves by the use of cobblestones or other protection.

The use of oil in lighter quantities, while not very efficient in preventing seepage, will no doubt prevent the growth of vegetation. * * *

Cement-mortar plaster, so extensively used in southern California, showed a saving in seepage water of 63 per cent. Better results were expected, and it is probably safe to expect a greater saving where good work is done, especially where the work is constructed in cold weather. This lining had to be applied when the temperature in the field was probably 110° or over. The cement mortar was mixed in small quantity and quickly applied. As soon as the setting had started the lining was sprinkled and covered with wet canvas, but even with these precautions better work could be done in cooler weather.

This plaster, while very efficient and economical on small ditches, would not be of sufficient thickness and strength to be used on the larger canals and laterals of larger irrigation systems, where a thickness of from 2 to 4 inches would no doubt be successful.

CEMENT PIPE FOR SMALL IRRIGATING SYSTEMS AND OTHER PURPOSES.^a

The need of better methods of using the limited water supplies available in many parts of the irrigated region, as illustrated by conditions in certain localities in Arizona, is thus presented by G. E. P. Smith in a bulletin of the Arizona Experiment Station:

Throughout southern Arizona there are scattered many sparsely settled valleys, traversed by the characteristic rivers of the arid region. These rivers are normally dry beds of sand, but at intervals they carry great floods of water. In most cases the soil, both of the bottom lands and the adjoining mesas, is fertile and easily cultivated, climatic and other conditions are good, and the markets are excellent. The water supply, however, is so slightly developed that agriculture is a very precarious business. Winter crops are sown with a large element of doubt as to whether harvests will be reaped, and through the summer much of the same land is not utilized at all, while adjacent areas of great productive capacity are still wastes of mesquite and catclaw. The water supply already developed in these valleys is largely derived from small ditches heading in the sandy river beds. A few pumping plants have been installed in favored localities.

While the area of irrigated land is being rapidly extended throughout the West, and many monumental enterprises are being developed, yet the smaller valleys above referred to seem to have been neglected and very little change has been wrought since their occupation began.

Without asserting that there are unlimited, or even abundant, water supplies for these valleys, yet it is demonstrably true that their cultivation can be very greatly extended, not only by largely increasing the water supply, but also by the adoption of modern methods in the development, distribution, and use of irrigating streams. At present the settlers are confronted with the many problems relating to such improved methods. The mountains must be surveyed for reservoir sites, the valley gravels

^a Compiled from Arizona Sta. Bul. 55.

must be explored and studied to locate and secure the water which they can yield, pumping plants must be more intelligently designed, for great economies are possible in their design and operation, the water must be saved from loss by seepage and evaporation in ditches, and the ground must be so mulched and cultivated as to conserve the water after it has been applied to the fields. It is no extravagance to say that by careful methods the present very low duty of water in these valleys can be more than doubled.

One of the most experienced irrigation engineers^a in the West has recently stated that, of the millions of dollars spent annually by our irrigated districts for water and for applying it to cultivated crops, fully 70 per cent of the money is wasted. What an opportunity is thus offered for investigation. What an argument for the introduction of methods that may result in utilizing a part of that 70 per cent which at present is not put to any beneficial use. It seems imperative that agricultural interests should join in a campaign for a higher duty of water. The main purpose of this bulletin is to discuss one phase of this campaign, namely, greater efficiency in transmission and distributing systems.

The same authority quoted above states that as a rule cultivated fields do not receive more than 66 gallons out of every 100 gallons of water which pass through the upper headgates, the rest being lost by seepage and evaporation. In Arizona the river beds and banks are usually of very porous sand and the ditches leading through these deposits suffer great loss of water. Occasionally the extreme case occurs in which the entire flow is thus lost. * * *

In seeking a remedy it is to be observed that seepage losses can be stopped by proper lining for ditches, while both seepage and evaporation are prevented by closed conduits. The materials available for these purposes are wood, cement, and clay. All have been employed in various parts of the West. The only one tried so far in southern Arizona has been wood; but its short life and the warping and leaking which it undergoes, together with high cost, unfit it for use in ditches. Cement pipe for small ditches and cement lining for large ones are from every point of view to be recommended. Clay tile lacks strength, and since at present it is subject to long freight hauls, its cost is very much greater than that of cement pipe. The latter is composed largely of sand and gravel found in the vicinity of the ditches and only the cement ingredient is subject to a freight charge.

There are other advantages in piping ditch waters besides the prevention of seepage and evaporation. The maintenance of open ditches is very difficult. Under the subtropical skies of Arizona weeds and algae grow rankly and unless removed at frequent intervals they soon obstruct and diminish the flow. The Flowing Wells ditch near Tucson costs \$80 per mile per year for cleaning alone. Furthermore, gophers perforate the ditch banks and cause the waste of rivulets for days or even weeks before the holes are discovered. Sometimes the holes enlarge and the ditch bank breaks, with consequent loss of the entire stream. The maintenance of cement pipe lines should be very slight.

To determine the practicability of making cement pipes and the best mixtures and methods to be used, Professor Smith established a small plant and made six different lots of 15-inch pipe, "this size being of such capacity as to adapt it to many streams belonging to individuals or small companies of ranchers." Using a very lean mixture of cement, lime paste, and sand, the paste being thinned to a consistency that permitted it to mix thoroughly with the sand, for the body of the pipes, and a mixture of 1 part cement and 3 parts sand for the bell ends, very satisfactory results were obtained.

^a Samuel Fortier, *Irrig. Age*, 21 (1906), p. 378.

The method of molding is described in detail. Several molding forms are on the market and can be rented by paying a small royalty. The molding outfit used in the experiments described contained molds for both bevel and tongue, and bell and spigot joints, and cost \$60. "It could be made ample for continuous operation at 40 tile per day for \$75 more."

The results of accurate observations on the cost of cement-sand and cement-lime-sand pipe are recorded in the following table:

Cost per 2-foot length of 15-inch pipe.

	Cement-sand.	Cement-lime-sand.
Cement at \$4.50 per barrel.....	\$0.563	\$0.375
Cement, hauling 7 miles.....	.035	.023
Lime at \$13 per ton, delivered.....		.058
Sand, no charge.....		
Water, no charge.....		
Labor: Foreman, \$2 per day; 2 laborers at \$1.25 per day.....	.112	.112
Wash of neat cement.....	.060	
Cost per 2-foot length.....	.770	.568
Cost per linear foot.....	.385	.284
Cost per mile.....	2,032.80	1,499.52

"Being made in close proximity to the river sand and within 20 feet of an irrigating ditch, no allowance is made for sand or water. [The] figures are based on Tucson prices during April, 1907, and must be modified to conform to the local prices at points where cement pipe lines are contemplated. * * * In some cases a considerable allowance should be made in the estimate for sand."

Observations on the construction of a redwood flume built in the same vicinity and at the same time as the cement pipe show that the cost of a flume of capacity (12 by 16 inches) equal to that of 15-inch pipe would be 25 per cent greater than the cement-sand pipe and 70 per cent greater than the cement-lime pipe, the differences amounting to \$528 and \$1,061 per mile, respectively. It must be borne in mind, too, that the chief advantages of the cement pipe are greater permanence and less loss of water by leakage.

The comparative merits of such pipe, clay tile, and concrete, crude oil, asphaltum, and puddled clay are discussed, the cement pipe being considered to possess decided superiority in many respects, particularly for the local conditions. The cement pipes are also shown to have a variety of other important uses.

The following example of the financial advantage of piping water in Arizona (and similar conditions are not uncommon elsewhere in the arid region) is cited:

In a certain ditch carrying about 100 miner's inches through sandy deposits, the loss of water per mile exceeds 10 per cent, say 10 miner's inches, capable of irrigating an additional 30 acres on the ranch, which would yield a net profit, estimated at \$30 per acre in alfalfa, of \$900 per year. This water could be carried in a 15-inch

pipe line costing \$2,500 laid, the interest on which at 8 per cent would be \$200. The maintenance of the pipe should be very much less than that of the open ditch; the frequent cleaning of the weeds and algæ would be entirely eliminated. The net profit resulting from the pipe line would therefore be \$700 per annum.

POLLINATION OF FORCED TOMATOES.^a

It is well known that greenhouse tomatoes do not set fruit freely during the midwinter season. The only satisfactory method for correcting this trouble is to fertilize the blossoms by hand. A description of this method, together with a discussion of the conditions favorable for pollinating, is given in a Farmers' Bulletin on "Tomatoes" of this Department.^b It is here desired to emphasize the importance of pollinating carefully and thoroughly. In house-grown tomatoes there is often a considerable percentage of one-sided fruit and of small fruit, which greatly detracts from the value of the crop. The general inferiority in size of winter-grown tomatoes can undoubtedly be attributed to the comparatively short periods of sunshine during that season of the year. On the other hand, the results of station investigations along this line show that imperfect pollination is an important cause of one-sided and small fruits. While working at the Cornell Station, W. M. Munson found that the amount of pollen used may have an important bearing in determining the form and size of the fruit.

In the winter of 1890-91, while crossing tomatoes, two stigmas in the same cluster of flowers were given different amounts of pollen. The first was given a very small amount—10 to 20 grains—on one side of the stigma; the other was given an excess of pollen, the stigma being well smeared. The effect on the form and size of the fruit was very marked. The fruit receiving the large amount of pollen was of normal size and nearly symmetrical in form, while the other was small and deformed. The larger fruit produced an abundance of seeds and all of the cells were well developed; the smaller developed seeds on one side only, while the other side was nearly solid.

The experiments were repeated several times during the following winter, and similar results were obtained, both when "the flower nearest the base of the cluster received an excess of pollen, while the other received a very small quantity on one side of the stigma" and when "the flower at the base received the small amount of pollen, while the other was given an excess," thus indicating that the relative position of the flower had no influence in determining this point.

No conclusion was reached by Munson as to the exact number of pollen grains necessary to insure proper fertilization, but in no case was fruit secured "when all pollen was excluded, and in every case

^a Compiled from Maine Sta. Rpt. 1892, pp. 48-51; Indiana Sta. Rpt. 1904, p. 17; Michigan Sta. Spec. Bul. 39; New York Cornell Sta. Bul. 28.

^b U. S. Dept. Agr., Farmers' Bul. 220.

the size of the fruit was in direct proportion to the amount of the pollen used."

Experiments with greenhouse tomatoes, recently reported from the Michigan Station by S. W. Fletcher and O. I. Gregg, not only confirm the results secured by Munson, but also appear to show, as indicated by earlier experiments by J. Troop of the Indiana Station, that there is no decided advantage to be gained by the cross pollination of varieties as compared with self-pollination. Six varieties of tomatoes were included in these experiments, viz: Ignotum, Stirling Castle, Earliana, Best-of-All, Lorillard, and Frogmore. "Four plants of each variety were used * * * to determine the effect of using varying amounts of pollen. All the flowers on one plant of each variety were emasculated and pollinated on one side of the stigma only. These invariably produced lop-sided and small fruits. All the flowers of one plant of each variety were pollinated with from one to five pollen grains. These produced very small, solid fruits, with an average weight of but 34 grams (about 1 ounce) and having no seeds, or but one or two. All of the flowers on one plant of each variety were pollinated with a large amount of pollen, spread all over the stigma. These produced fruits that were smoother and averaged 12 grams heavier than fruits produced from flowers that had but a small amount of pollen applied all over the stigma." The conclusions deduced from this work are that "when pollen falls upon one side of the stigma only, a one-sided tomato always results. The larger the stigma the greater the irregularity. The amount of pollen applied to the stigma determines to a great extent the size and smoothness of the tomato; but after applying a certain amount of pollen no further increase in size or weight results by applying more. The small, irregular tomatoes grown under glass are caused largely by insufficient pollination."

With the view of throwing some light on the relative value of cross and self pollination, "the blossoms on four plants of each variety were self-pollinated, and the blossoms of eight plants of each variety were cross pollinated with two other varieties. All set fruit equally well. The 265 fruits produced from self-pollination on all six varieties had an average weight of 77.3 grams. The 534 fruits produced from cross pollination on all six varieties had an average weight of 79.1 grams," from which it will be seen that there was practically no gain in the total number of cross pollinated fruits secured, and but a slight difference in the weight of the individual fruits in favor of cross pollination.

Although it does not appear necessary to raise several varieties for the purpose of cross pollination, there is no harm in alternating such varieties as are grown, and in some cases a possible benefit may be obtained, such as a slight increase in the average weight of the fruit.

All of the experiments, however, do show most conclusively that the setting of a good crop of smooth, heavy fruit depends very largely upon the care taken in distributing the pollen, especially during the cloudy weather which is likely to be of frequent occurrence in midwinter.

INCREASING THE PRODUCTIVENESS OF CORN.^a

The production of every crop is influenced by many different factors, and in so far as these are under control the yield may be increased and the fertility of the land maintained or improved. It is necessary, therefore, to take all the different factors into consideration to reach the maximum production. In a recent bulletin of the Kansas Experiment Station, Professors Ten Eyck and Shoemith describe the results of a series of experiments with corn carried on for four years, in which the more important factors entering into the production of larger and more profitable crops were taken into account.

VARIETIES.

During the period of the experiments 112 varieties of corn were planted for trial and comparison. The methods of cultivation for the last three years of the variety test are described. In 1904 the land was disked twice from March 10 to 15 for the purpose of conserving the soil moisture, and a second disking was given April 29 to May 2, just prior to listing the corn in furrows about 5 inches deep, with the rows $3\frac{1}{2}$ feet apart and the kernels 16 inches apart in the row. For the test in 1905 the land was plowed November 24 to December 10, harrowed March 29 and again April 10, and the corn planted with a planter on April 28 and 29 at the same distances used in 1904. In 1906 the varieties were planted after winter wheat, followed by rape in the stubble after harvest, which was plowed under when about 16 inches high near the middle of October. The land was disked soon after plowing and was harrowed twice in the spring before planting. The corn was planted May 2 to 4 in the same manner as the year before.

Of all the varieties tested Hildreth, Kansas Sunflower, McAuley, Forsythe Favorite, Golden Row, Hammett, Leaming, U. S. P. B. Selection No. 77, Hogue Yellow Dent, Sander Improved, White Salamander, Red Cob White Dent, White Injun, Legal Tender, Warner, Mammoth Golden Yellow, Dyche, Meinhardt, and Hiawatha Yellow Dent were superior in productiveness. The ten most productive varieties in the three years, 1904-1906, ranged in average yield from 57.81 to 61.25 bushels, and the ten highest for the four years from 58.05 to 65.21 bushels per acre. In 1905 the 75 different

^aCompiled from Kansas Sta. Bul. 147.

varieties tested matured in 121 to 143 days, the average period being 129 days. Of 35 varieties grown for four years the 16 which required 126 days or less to mature gave an average yield of 61.45 bushels, while the rows requiring 127 or more days yielded on an average 64.94 bushels per acre.

White Injun, which held the highest 3-year record, is a red-cobbed white dent and a selection from Red Injun No. 81, originally selected by the station for breeding on account of its deep kernels and well-filled butts and tips. Red Cob White Dent, a hardy variety of medium growth and maturity and fairly uniform type, is considered valuable for general planting. McAuley, which also ranked high as a good yielder, is a white dent of fairly uniform type resembling Boone County White. It is described as medium late in maturing, of vigorous growth, hardy, and well suited to bottom land or fertile upland. Golden Row and Hogue Yellow Dent, received from the Nebraska Experiment Station, appeared to be well adapted to the northern part of the State.

The results of the variety tests also showed that Kansas-grown corn is better adapted to Kansas than seed corn from other States, although pure bred and highly productive. It is recommended that the varieties generally grown within the State be more extensively tested and improved and that some of the best varieties from other States be thoroughly adapted to the conditions prevailing in Kansas before their general dissemination.^a

MOISTURE CONTENT.

After husking, the percentage of moisture in the different varieties of corn was determined by drying the kernels and cobs separately in an oven at 110° C. In 1904 the moisture content in the ear corn ranged from 11.90 to 29.02 per cent, in 1905 from 11.66 to 21.86 per cent, and in 1906 from 10.73 to 19.43 per cent. The data secured are taken as indicating that under Kansas conditions well-cured ear corn put into the crib in the fall contains on an average about 15 per cent of moisture.

METHODS OF CULTURE.

A comparison of different methods of preparing land for corn was begun in 1903. Early in April one plat of corn stubble land was double disked, another double disked and harrowed, a third listed in furrows 3½ feet apart, a fourth plowed and harrowed after plowing, and a fifth received no treatment. Early in May all plats were planted with a lister. On plat 3 the ridges were split at planting time, the corn being planted in the newly listed furrows. In 1904 and 1905 several additional treatments were introduced. One plat

^a See also U. S. Dept. Agr., Farmers' Bul. 244, p. 7.

was plowed 6 to 8 inches deep, another 3 to 4 inches deep, and both were planted with the surface planter. In another set of plats the first was plowed and planted with a lister, the second was listed early and the corn planted in the same furrows, and the third was treated the same as plat 3, described above. These different treatments were always given as soon as the soil was in condition for cultivation. The results of these different methods of preparing the seed bed showed that listing early in the spring and splitting the ridges at planting time gave an increase in yield of 5.02 bushels per acre over land receiving no early treatment. No difference in the average yield apparently due to other early treatment was observed. During the four seasons surface planting yielded on an average 6.65 bushels more corn and 469 pounds more stover per acre than listing.

In a single trial in 1905 surface planting with a disk furrow opener attachment yielded 53.24 bushels, ordinary surface planting 51.94, and listing 48.33 bushels per acre. The furrow opener is a device intended to secure the advantages of listing corn without all of its disadvantages. It was observed that the corn planted with the disk furrow openers sprouted quicker and made a more vigorous early growth than surface-planted corn, and that it retained this advantage throughout the season.

There is an advantage, also, in cultivating the disk-furrow planted corn similar to that secured by listing, in that the weeds in the row are more easily covered and destroyed by the early cultivation than is the case with surface-planted corn. Also, there may be a similar advantage, as obtained by listing, in that the corn roots lie relatively deeper in the soil and are covered with a greater depth of mellow soil at the last cultivation when the corn is laid by. It is well to remember, however, that when the furrow openers are used it is necessary to plow the land and prepare a good seed bed the same as for surface planting, and also that it requires four horses to operate the corn planter with the furrow-opener attachment.

The soil moisture determinations made show without exception that listing as compared with surface planting favored the conservation of soil moisture in the latter part of the season. This result is considered as possibly due to the larger growth of surface-planted corn, to the level culture given listed corn and the slight hilling of the surface-planted crop, and to the last cultivation of the listed corn being uniformly deeper than in the case of the surface-planted plats.

For two years tests were conducted with planting at different dates, and the average results show that planting May 26 gave the best yields, and that the May plantings gave better results than the April plantings.

Cultivation experiments were conducted only with surface-planted corn. Four cultivations were given each season. One plat was cultivated shallow and another deep throughout the season and on two plats the first two cultivations on the one were shallow and the

last two deep, while on the other this plan was reversed. Shallow cultivation was about $1\frac{1}{2}$ inches and deep cultivation about $3\frac{1}{2}$ to 4 inches deep. The disk cultivator and the weeder were also used to some extent in these tests. The average yields for the several seasons did not vary much and the results are taken as indicating that the exact method of cultivating is not so important as the conditions of soil and season. It was observed, however, that each season the shallow cultivated corn matured several days later than the deep cultivated corn, and further that in case of the shallow cultivation laying the corn by was a decided advantage, the average yields of stover being the greater on the plats receiving this treatment. The weeder proved effective on mellow soil when the weeds were small, but on hard ground with large weeds it did not take the place of a good cultivator.

FERTILIZERS.

In comparative fertilizer tests carried on in 1906 the largest yield, 56.63 bushels per acre, was secured on land treated with 13 tons of barnyard manure per acre. The next largest yield, 40 bushels per acre, was obtained on a plat treated with 50 pounds of nitrate of soda applied broadcast. The average production of the unfertilized land was 33.21 bushels per acre.

ROTATIONS.

The following crops were grown in rotation: Wheat, wheat followed by cowpeas as a catch crop, oats, barley, emmer, flax, millet, sorghum, Kafir corn, corn, corn followed by cowpeas as a catch crop, corn followed by rye as a catch crop, soy beans, and potatoes. The arrangement was such that each year corn was grown after the various crops and the various crops after corn, and the object of this rotation test was to study the effect of each of these crops upon the growing of corn. The data secured show that the largest average crop of corn, 69.98 bushels per acre, was grown after potatoes. The second largest yield of corn, 67.55 bushels per acre, was produced after soy beans, and the third largest, 60.74 bushels, after corn. After the other crops the yields were smaller than where corn was grown after corn, the lowest yields being produced after Kafir corn and sorghum. In average value of total products the rotation of corn with potatoes ranked first, with \$43.47 per acre, the corn being valued at \$20.99 and the potatoes at \$22.48, corn after Kafir corn second, with \$34.46 per acre, corn after sorghum third, with \$31.15, and corn continuously fourth, with \$31.07. While the lowest yields of corn were produced after Kafir corn and sorghum, the large yields of these crops made the value of the total production from these rotations relatively high.

The plats growing corn continuously, in which rye was sown each fall ranked third in average yield and fourth in value of total production.

A catch crop of rye in corn helps to eradicate weeds, utilizes available plant food left in the soil in the fall which otherwise might be washed out or drained away, provides a protection to the soil through the fall and winter, thus preventing the soil from blowing, catching the rain, and stopping the drifting snow. When corn follows rye in this way it is necessary to plow or double list, and this should be done rather early in the spring, unless it is preferable to plow late in the fall. If rye is plowed under late in spring, the seed bed is apt to be left loose and dry, and if corn is listed in rye, the rye becomes a troublesome weed which is difficult to destroy and which may injure the growth of the corn.

The sowing of rye in the corn seemed to give better results than the catch crop of cowpeas, but a marked increase in yield of corn after wheat and cowpeas, amounting to 8.76 bushels per acre, showed the value of this crop as a fertilizer when grown between small grain and corn. The apparent advantage of rye over cowpeas in this test is considered due to the fact that the rye, having been sown late, did not compete with the corn for moisture and plant food to the same extent as the cowpeas, which had been sown earlier in the season. None of the rotation systems tried are regarded as ideal, as a practical and scientific rotation is intended not only to produce large yields, but also to maintain the fertility of the soil, and that such a rotation would include grasses and perennial leguminous crops, as well as the growth of annual leguminous plants and catch crops.

BREEDING.

In corn-breeding work the station found in some tests a difference of more than 400 per cent of the yields from different ear rows. In 1906, the Silvermine high-yielding-rows seed plat yielded 32 per cent more corn and 24.8 per cent more first-grade seed ears than the plat planted with first-grade seed. The Hildreth high-yielding-rows seed bed yielded 10.36 per cent more corn and 40 per cent more first-grade seed ears than the plat planted with first-grade seed of this variety. It is pointed out that the results of the breeding work show that the individuality of certain ears can be utilized in the improvement of a particular breed or variety. The breeding stock of Kansas Sunflower corn, after four years' breeding by the station, traces back to two original mother ears. Germination tests indicated that ears of corn may vary greatly in vitality regardless of selection and preservation, and that it is therefore very important that each ear of seed corn be subjected to germination tests in order to remove those of low vitality.

SHRINKAGE OF CORN IN CRIBS.^a

In connection with the marketing of many farm products shrinkage is always an important consideration. Farm crops generally are subject to shrinkage when put in storage after harvest, but it often amounts to so little that it is entirely disregarded. In ear corn and hay, however, the loss of weight during storage may be quite large, and with these crops, therefore, shrinkage is as a rule taken into account. That ear corn generally sustains important losses in weight during storage is so commonly acknowledged that in many localities the custom prevails of taking 75 pounds of ear corn for a bushel in the fall and only 70 pounds in the spring. Observations on the shrinkage of stored crops have been made by several of the experiment stations, and the results have been noted in a previous bulletin of this series.^b

In some of the more recent work along this line by the Illinois Station the purpose was to ascertain whether it would be more profitable to market corn as early as possible after husking or to hold it until winter or spring before selling it. Not only the losses in weight were determined, but the increases in price necessary to compensate for these losses were also calculated.

For the purpose of making these observations on the shrinkage of stored ear corn cribs were constructed at Urbana and Sibley in such a manner that they could be lowered to rest upon the platforms of large wagon scales and weighed. At Sibley a check experiment was made by weighing each wagonload of corn as it was put into a stationary crib constructed of ordinary fencing lumber on blocks and weighing out all the corn when the crib was emptied at the end of the trial. The first year the shrinkages of the two cribs at Urbana and Sibley varied between 12.3 and 19.8 per cent.

The data secured from other weighings and also the results from some preliminary trials are reported. On December 6, 1901, 20,545 pounds of corn were weighed into a crib at Sibley and weighed out again September 25, 1903, when the weight was found to be 18,690 pounds. The loss in weight amounted to 1,855 pounds, or 9 per cent for the entire period of over 22 months. Another crib close by, receiving the same amount and kind of corn and filled and emptied on the same dates as the other, showed a loss of 1,895 pounds, or 9.2 per cent. In still another test a stationary crib was filled during the week preceding November 11, 1905, with 19,850 pounds of ear corn. November 3, 1906, when the corn was taken out of the crib it weighed 17,280 pounds, showing a loss of 12.9 per cent for the year. Taking all the trials into consideration the loss in weight of the corn in the

^a Compiled from Illinois Sta. Bul. 113; Kansas Sta. Bul. 147.

^b U. S. Dept. Agr., Farmers' Bul. 149.

different cribs ranged between 9 and 20.7 per cent for nearly two years' storage.

The data secured also indicate that the shrinkage for the second quarter of the year was not much in excess of that for the first, the difference being an average of only 2.10 per cent. The shrinkage for the third quarter, however, was noticeably greater than that of the second, the average difference being 8.70 per cent, while the shrinkage for the last quarter from June to September averaged only 2.10 per cent. It was found that by far the most noticeable shrinkage of ear corn in the cribs occurred during the months of April and May, after which period the corn sustained only a gradual loss.

The observations made on the loss in weight during the second year of storage point to the fact that practically all moisture comes out of ear corn during the first year of storage. In a trial at Sibley continued through the second year the shrinkage was 19.6 per cent at the beginning of the year and had only increased to 20.5 per cent by the following September. At Urbana the corn also lost 1 per cent in weight during the second year. From these results it is concluded that it seems safe to assume that old corn may be stored in cribs with very slight loss from shrinkage. The weekly weighings showed that the crib weights were influenced by the amount of moisture in the atmosphere.

In determining the increase in price that must take place between cribbing time and the following December, March, June, and September, it was assumed that the corn might have been marketed at cribbing time for 35 cents per bushel, and the average of the "high" and "low" Chicago cash prices for December and May as summarized from the Yearbook of this Department for 1905, which shows a difference of 3.8 cents per bushel in favor of May, was also taken as one of the factors in the calculation. Furthermore, it was pointed out that this average difference in price and the allowance of 5 pounds per bushel for shrinkage would make the actual average rise in price between May and December 6.3 cents per bushel. This computation shows that when the percentage of decrease in the weight of ear corn up to and including September of the first year runs from 12 per cent to nearly 20 per cent, as in the four different trials under consideration, an increase in price for September varying between 4.9 and 8.6 cents per bushel is necessary to cover the loss in weight and to insure the farmer against financial loss in holding his corn. In two of the trials the decrease in weight between December and June was greater than would be covered by the average increase in price of 6.3 cents between December and May, while in the other two trials it was smaller, so that the average increase in price, including the usual 5 pounds decrease in the number of pounds taken from 1 bushel, is considered as possibly covering the average shrinkage.

At the Kansas Station shrinkage experiments were conducted for three years in three small board cribs holding about 4,000 pounds of ear corn each. The cribs were lined with fine wire netting in order to confine the loss in weight as much as possible to the actual shrinkage of the stored corn. They were filled each fall when the crop was in good condition for storing with Forsythe Favorite and McAuley, white dent varieties, Reid Yellow Dent, Kansas Sunflower, and Hildreth, yellow dent varieties, and with mixed corn consisting of a few bushels each of many different varieties.

In 1903 the white corn at husking time contained 24.94 per cent of moisture and the yellow corn 19.73 per cent. The corn lost 2.33 per cent in weight on the average during the first month, with but little decrease in weight during the rest of the winter, but by May 6 the total average loss for all cribs had reached 6.14 per cent. The yellow corn showed a loss of 5.66 per cent in the last month of the trial, but in the other tests the weight of the corn remained about the same through the summer. The final weights showed a shrinkage of 7.92 per cent as an average for eight and one-half months for all cribs. The white and yellow dent corn lost on the average 3.79 per cent more in weight than the mixed corn.

In 1904 the corn ripened earlier than in 1903 and the first comparative weights were taken October 26, as compared with December 5 in the previous year. The white corn contained 18.95 per cent of moisture and the yellow corn 21.32 per cent when put into the crib. On January 31 the average loss in weight in all cribs was 5.17 per cent, the yellow corn showing the greatest decrease. Again, there was little loss in weight during the winter but a great shrinkage in weight during the spring and early summer months. The lowest weights for the year, with the exception of yellow corn, were recorded on June 20, the average shrinkage at that date being 11.32 per cent. The final weights taken October 7 showed an average shrinkage of 12.21 per cent. As in the year before the mixed corn again lost least in weight, the ratio of shrinkage being 6.72 to 14.88 per cent for the yellow and white corn. On July 20 and August 24 an actual gain in the average weight of the cribs was recorded and the mixed corn continued to gain from August 24 to the end of the test.

In 1905 the first comparative weights were taken November 16. By December 23 the cribs had lost only about one-half of 1 per cent of weight on the average and the crib of white corn had actually gained in weight. On February 6 the average shrinkage was 2.26 per cent and on April 19, 3.86 per cent. All cribs gained in weight during May, after which there was a gradual decrease in weight until October 16, when the final weights showed an average shrinkage for the entire test of 5.82 per cent in eleven months. The yellow corn showed a loss of 8.48 per cent in weight, the mixed corn of 6.42 per cent, and the white corn only 2.44 per cent during the whole period.

Five samples of white corn at husking time contained on the average 15.2 per cent of moisture and a single sample of Reid Yellow Dent, husked a little earlier than the white, contained 18.9 per cent.

It is pointed out that the average results indicate that when corn is put into the crib fairly dry and in good condition the shrinkage during the winter months is not great, being a trifle over 5 per cent as an average for the first six months after the corn was cribbed, and that this loss would not be sufficient usually to equal the difference in weights which are required for a bushel of ear corn as sold in the fall and as it may be sold in the winter or early spring. It is believed that the loss on the original weight in the eight or ten months is not so great as the decrease in the actual value of the corn, when considering that at husking time the price is often more than 10 per cent less than in the spring or early summer. The total shrinkage of weight in a year of the nine cribs of corn was only 8.62 per cent. Attention is called to the fact, however, that precaution was taken to avoid loss in weight from other causes than shrinkage.

As to whether the farmer should hold his corn or sell it early in the winter may depend upon several factors, as the price of corn, size of the general crop, condition at husking time, and the accommodation which the farmer may have for saving his crop. If the crop is normal and the price of corn is unusually low at husking time, and the farmer has a good crop, the usual recommendation would be to hold the corn. Judging from these experiments corn may be kept safely without great loss in weight until March or April, and if there is a question as to the success of the new crop it may be advisable to hold old corn even later than the date named. However, in Kansas, and in States farther south, old corn is very apt to become infected with the grain weevil or grain moth and great loss occasioned in this way, provided the corn is held too late in the summer. In the northern States, where these pests do not prevail, corn may be safely held for late summer and early fall sale.

The results of the tests also indicate that the shrinkage in corn is not due entirely to the loss of moisture, but that there is an actual loss of dry matter. Samples of Forsythe Favorite cribbed in 1904 contained on October 25, 1905, 11.87 per cent of moisture in the grain, 12.85 per cent of moisture in the cobs, and 12.05 per cent in the ear corn, and a sample of ear corn taken from the seed-corn room on this date contained 11.42 per cent of moisture.

The shrinkage in the weight of the white corn in 1904-5, due to loss of moisture, could not have been more than 6.9 per cent, since the new corn contained only 18.95 per cent of moisture when it was put into the crib. However, the white corn actually lost 14.48 per cent in weight in the trial referred to, and it will be observed that in almost every case the shrinkage in the weight of the corn was greater than may be accounted for by the loss of moisture.

Hildreth corn cribbed in the fall of 1906 contained 19.75 per cent of moisture in the ear corn and separate determinations showed that the grain contained 17.72 per cent of moisture, while the cobs contained 29.36 per cent. The sample contained 82.6 per cent of shelled corn and 17.4 per cent of cob. From these data it appears that the

eobs and grain become about equally dry in old eorn. "If the minimum moisture in the dry eorn reaches 12 per cent this would give a shrinkage of 5.72 per cent in the grain and 17.36 per cent in the eobs, or an nverage shrinkage of 7.75 pounds for each hundred pounds of ears, and 3.02 pounds of this shrinkage, or 39 per cent of the total shrinkage, would actually oocur from the drying out of the eobs."

FEEDING GRAIN TO MILCH COWS AT PASTURE.^a

Under advanced methods of dairy farming it is reecognized as essential to the greatest suceess to maintain the highest and most uniform flow of milk praeticable throughout the year. Now, when good pasturage is available the change from barn feeding to pasture is as a rule highly beneficial, both as regards yield and quality of milk and health of the cows, but even in good grazing regions there are frequently parts of the season, usually late summer, when the pastures are apt to become dry and thus make it a matter of much praetieal importance to find some means of keeping up the milk flow. For this purpose the praetice of feeding either grain or soiling crops to supplement the pasture has been suggested. The economy of feeding grain to eows at pasture has been a subject of investigation by several of the experiment stations.

In experiments at the Kansas Station a number of years ago "two lots of cows each were fed alternately on rations consisting of pasture alone, pasture and bran, pasture and eorn meal, and pasture and ground oats, for periods of seven days each." The conclusion was that although the grain feed added materially to the milk yield, eorn meal showing the greatest increase, the increased returns did not pay the cost of the grain. In faet there was a considerable loss.

In experiments at the New York Cornell Station one lot of cows was fed, from June 8 to September 21, a daily ration of 2 pounds of cotton-seed meal and 2 pounds of bran per eow, and another lot was fed, from May 25 to September 17, 6 to 9 pounds daily per eow of a mixture of wheat bran 100 pounds, cotton-seed meal 100 pounds, and malt sprouts 15 pounds, in addition to good blue-grass pasture. In neither case was there any profitable return in milk or butter for the additional grain fed.

In experiments with cows soiled in the barn on fresh grass there was an increase in the milk and butter production and a saving in grass barely sufficient to pay the cost of the added grain ration.

To determine whether the profit from grain feeding would be greater in case of poorer pasturage a herd of eows on light pasture was divided into two similar lots, one lot receiving only pasture and soiling, the other, beginning May 23, was fed 4 quarts per eow daily

^a Compiled from Mississippi Sta. Rpt. 1900, p. 31; New York Cornell Sta. Buls. 13, 22, 36, 97.

(two feeds, night and morning), of a mixture of equal parts of corn meal, wheat bran, and cotton-seed meal. "On August 10, the pastures having become dry, both lots began to receive a ration of green corn fodder of about 16 pounds per cow per day. On September 9 the corn fodder ration was changed to millet, which continued until October 1, when second growth grass was used; this continued until October 13, when pumpkin began to be fed." The grain feeding in this case resulted in a profitable increase in milk production and also in a considerable gain in weight of the cows. The beneficial effect of the grain feeding was observable the following season, particularly in the development and performance of the younger animals (2-year and 3-year olds).

At the Mississippi Station no benefit was derived from feeding 3 to 4 pounds of cotton-seed meal and 4 to 6 pounds of wheat bran per cow daily to cows running on good pasture.

The question of grain feeding of cows at pasture has recently been investigated anew by J. H. Stewart and H. Atwood of the West Virginia Station. They found that there was no direct financial gain from feeding 6 pounds per cow daily of a rather rich grain feed containing 16.5 per cent protein and 3.5 per cent of fat to cows on pasture, notwithstanding the fact that in some cases the pasture became short from drought. "It is true that the cows which received grain were uniformly in somewhat better flesh than those that did not receive grain, but as far as the milk yield was concerned the increased flow was produced at an actual loss."

Summarizing the results of all the experiments which have been made on the subject, the conclusion seems justified "that unless dairy products are especially high in price it is not a profitable practice to feed grain to cows at pasture. It is true that more milk is obtained and the cows hold up their yield better and remain in better flesh when receiving the grain rations, but under ordinary circumstances there is no direct profit from the grain feeding, as the increased production usually costs more than it can be sold for."

PRACTICAL USE OF STARTERS IN RIPENING CREAM.^a

In recent years butter and cheese makers have more generally adopted methods of manufacture that involved the use of cultures of bacteria, commonly known as starters, for the production of desired characteristics of flavor, aroma, etc. Under these conditions constancy in results depends largely upon uniformity in the quality of the starters employed. Considerable use is made of commercial starters, the quality of which is quite permanent, but the expense for

^a Compiled from Michigan Sta. Bul. 246.

starters is a considerable item. The desirable organisms having been obtained, they may be used according to a method recently described by L. D. Bushnell and W. R. Wright in a bulletin of the Michigan Station, which is designed to insure a permanent quality of starters and at the same time to lessen the actual expenditure for them. The method as described is applicable to butter making, but it could be easily adapted for use by the cheese maker also.

Some of the commercial starter usually employed is put into sterilized whole milk and allowed to develop there for twenty-four hours at a favorable temperature. For ease in manipulation the milk is sterilized in a quart bottle plugged with cotton. On the second day a portion of this milk is transferred to another bottle of sterile milk to continue the growth of the organisms, and the remainder is poured into a can of recently pasteurized skim milk. The latter is again kept for twenty-four hours at a temperature favorable to the growth of the organisms, and is then used as a starter for sweet cream. At the same time a portion of the second bottle of inoculated sterile milk, in which the organisms have been growing for twenty-four hours, is transferred to a third bottle of sterile milk, and the remainder of the second bottle used to inoculate another can of pasteurized skim milk for use as a starter on the following day. It is claimed that this method of growing the bacteria, if properly handled, will maintain a culture that will give uniform results for an indefinite period.

According to F. O. Foster, instructor in dairying at the Michigan Agricultural College, who has confirmed the application of the method to dairy practice, the advantages in it are as follows:

The starter can be kept for a much longer period, thus saving one-half or more of the cost of pure cultures.

The milk is always ready for inoculation and the mother starter can be transferred each day when in the best condition and kept vigorous.

In case a starter is not needed every day, the mother starter can be carried along conveniently without the trouble of sterilizing milk.

After a thorough trial we have adopted the method for our daily use. We find it no great task to sterilize the bottles of milk once or twice a month, and the little extra labor thus occasioned is more than offset by the convenience and sureness of the new method.

WATER PANS FOR POULTRY.^a

Nothing is more important and few things are more difficult to insure than clean water for poultry. Ordinary receptacles and sources of water supply are as a rule quickly fouled and thus become breeders of disease. Poultry raisers generally recognize the importance of a watering device which will keep the water as free as pos-

^a Compiled from New York Cornell Sta. Bul. 248.

sible from the dust and litter of the poultry house or yard and from the droppings of the fowls, and many forms of such devices have been devised. One that is simple in construction and has been found to be very satisfactory in use is described by J. E. Rice and R. C. Lawry in a bulletin of the New York Cornell Experiment Station. The construction of this watering pan is shown in figures 1, 2, and 3.

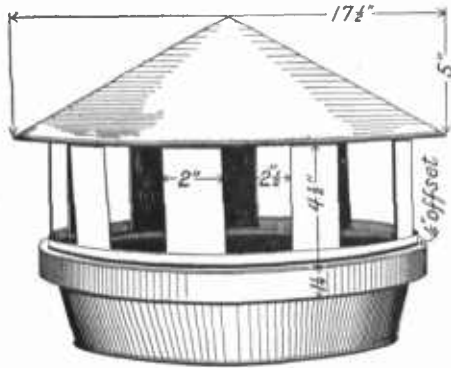


FIG. 1.—Sanitary water pan, showing the small space open for entrance of litter.

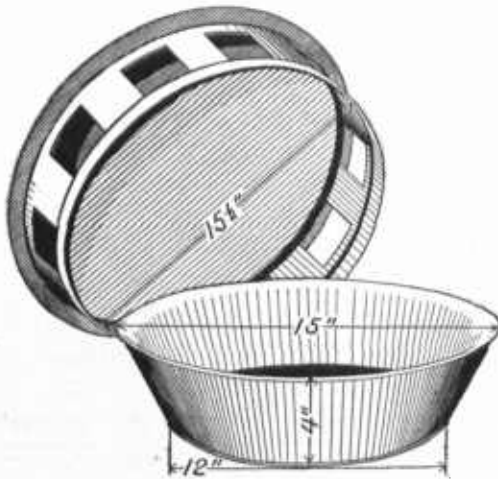


FIG. 2.—Sanitary water pan uncovered, showing flanged rim of cover.

The round, deep pan with flaring sides, is more easily emptied without injury to the pan in case of hard freezing. It presents a comparatively small surface to catch dust and dirt. The round, cone-shaped top prevents the fowls from roosting upon it. The openings in the side walls permit the fowls to drink from different sides at one time, and presents the smallest possible amount of opening for dust and litter to enter. The platform on which it stands, being 10 inches from the floor, is

high enough to prevent the litter being scratched into it. It is found that where water pans are placed much higher than this, fowls do not drink as much water. The water pan and cover is made of No. 26 galvanized iron. It should not cost to exceed \$1.40.

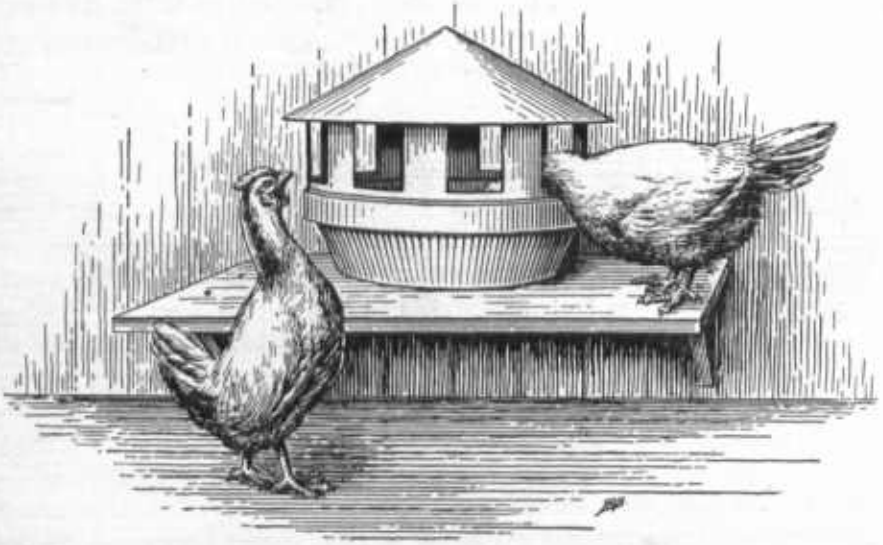


FIG. 3.—Sanitary water pan and cover in use on platform 10 inches above the floor.

Another form of water pan and “an inexpensive, handy, serviceable device” for keeping it clean is shown in figures 4 and 5. With



FIG. 4.—Water pan with cover lowered to prevent hens getting into the pan and the entrance of litter and dust.

this arrangement it is easy to empty or fill the pan, which should be placed on a slatted platform 10 inches above the floor and may be used to water either one or two pens.



FIG. 5.—Cover raised for emptying or filling the pan. The water pan is arranged to supply two pens.

CATCHING HOOK FOR POULTRY.^a

In a recent bulletin of the New York Cornell Experiment Station R. C. Lawry says: "Every poultry farm should have several catching hooks. They save time in catching fowls and prevent much of the fright and injury which usually occurs on such occasions."



FIG. 6.—Catching hook, with wire turned back to avoid injury, wide open to catch quickly, and restricted clutch with enlarged hold.

He describes a catching hook which is an improvement of an old invention. The improvements described consist in so fortifying and bracing the wire portion of the device that it remains practically rigid, and in so shaping the hook end that the shank of the fowl may be easily caught and effectively held without injury. The only materials

^a Compiled from New York Cornell Sta. Bul. 248.

required for the construction of the hook are a broom handle and a 6-foot piece of No. 10 steel wire, which can easily be bent into the proper shape. As figure 6 shows, the hook end should have a restricted entrance which makes it difficult for the fowl to withdraw its shank, but it should also have a large aperture which gives freedom of action while the shank is held. Rigidity of the wire portion of the hook is obtained by reinforcing it for a considerable part of its length from the handle by a second piece of wire.

In using the hook it will be found that the wire portion is less conspicuous than the wooden handle and that the latter attracts the fowl's attention while the shank is caught by the hook. The fowl is then gently drawn from the flock, and the shape of the hook is such that the foot may easily be released.